Sustainable Water Consumption: Options for Grey Water Filtration Systems for Homes

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***Abstract*— Water is one of the most important resources for the existence of life on our planet and to keep it. Nowadays, this resource is in danger due to the careless use that it has been given over the years, growing demand and climate change. For these reasons, several countries in the world have serious water crises or they are on the way to having them. One way to fight against the water crisis is the recovery of otherwise discarded water through greywater treatments.**

The aim of this paper is to delve into the technologies available today to realize greywater treatments at homes anywhere. In this paper, different types of filter systems which use physical and chemical methods will be presented. In addition, it will show advantages and disadvantages of each treatment system and their application in homes.

***Keywords*- water scarcity, grey water, filtration systems**

***Resumen*— El agua es uno de los recursos más importantes para que exista vida en nuestro planeta y para que ésta siga adelante. Hoy en día, este recurso se encuentra en peligro debido al mal uso que ha tenido a lo largo de los años, a la creciente demanda del recurso y al cambio climático. Por estas razones, varios países del mundo tienen graves crisis hídricas o están en camino a tenerlas. Una de las formas para luchar contra la crisis del agua, es usarla de una mejor manera sin generar desperdicios mediante el tratamiento de aguas grises.**

El propósito de este artículo es profundizar en las tecnologías que hoy existen para realizar un tratamiento de aguas grises en los hogares en cualquier parte del mundo. Aquí se presentarán distintos tipos de sistemas de filtros para realizar el tratamiento de aguas grises los cuales utilizan métodos físicos y químicos. Además, se mostrarán las ventajas y desventajas de cada sistema de tratamientos y de su aplicación en los hogares.

***Palabras clave*- escasez de agua, aguas grises, sistemas de filtrado**

I. INTRODUCTION

Water is the most important natural resource in all aspects of life. We, human beings, are composed of 70% of it, which shows how important it is for our survival. Also, water plays a very important role in the world and in life because just 2.5% of the total water on the planet is fresh so it is important to take care of this resource.

In past decades, it was not usual to control the excess use of water because the problem that this would generate was not known. Over the years, the scarcity of this resource began to be noticed in various parts of the world, mainly in those that suffer from drought, for example, California. Large droughts are recorded there every two years, causing the reduction of water basins. In the same way, other places of the world are affected by droughts setting records of minimum levels on important rivers [1] such as China's Yangtze River, Italy's Tiber River, and Serbia's Danube River.

The lack of this resource results in animal and plant death. Also, it affects 40% of the world´s population, causing fatal diseases due to the consumption of unsafe water or due to lack of hygiene. Climate change, excessive consumption and contamination of water resources are some of the factors that aggravate water scarcity, making this problem one of the top three global risks.

There are various solutions to counter this problem and one of these is sewage water reutilization. Sewage water is water with impurities that comes mainly from domestic discharges. Two types of sewage water can be distinguished: grey water (shower, bathroom sinks and laundry machines) and black water (toilets, dishwasher and kitchen sinks). Most usually this differentiation between these types of sewage water is not made in the piping system, resulting in the discharge of water that carries practically zero bacteriological content together with highly contaminating water.

Grey water reutilization is a workable way to reduce the excessive consumption of potable water due to the fact that it could be easily treated and stored for later, giving it various uses, such as garden and orchard irrigation, car and sidewalk washing or toilet recharging. In this way, lots of potable water consumption in a house can be reduced, which generates a representative change in water consumption reduction on a large scale.

The need to address this issue is not a local one. The United Nations (UN) specifies it in its Sustainable Development Goal 6 [2, p.38], which calls for guaranteeing the availability of water, its sustainable management and its adequate sanitation.

This paper aims to delve into grey water reutilization for home applications. In order to do this, first, this work analyses the current situation about the water crisis around the world. Later, this paper studies the possible types of filter systems that can be used as well as the advantages and disadvantages of each. Finally, this paper carries out a comparative analysis between the installation of these systems in existing houses and new houses.

II. ANALYSIS AND SOLUTION TO THE WATER CRISIS

A lot of countries are affected by the problem of drought such as the EEUU, Argentina or Australia, which every year fight against fires and crop loss caused by this effect. However, droughts are just one part of the problem since there are several places with water scarcity or limited

availability of this resource which further complicate the water emergency of these countries.

A. *Water consumed around the world*

Data from the City of Melbourne [3] show that a person consumed an average of 340 liters of water per day in 2015. In dry zones, the amount of water that a person consumes per day was more than double. Fig.1 [3] shows the percentage of the amount of water consumed by an average household in Melbourne.

Fig.1. Percentages of water consumption in Melbourne. [3].

In the same way, data from the City of Sydney [4] indicate that people consume an average of 200 liters of water per day to satisfy basic needs and for recreational activities. Fig.2 [4] indicates the percentage distribution of water uses.

Fig.2. Percentages of water consumption in Sydney. [4].

According to the Legislative Analyst's Office (LAO) [5], California's citizens consumed around of 85 gallons (320 liters) of water per day in 2016. Fig.3 [5] shows the values of water consumption collected month by month and it shows an increase in water consumption during the summer months going over 110 gallons (416 liters).

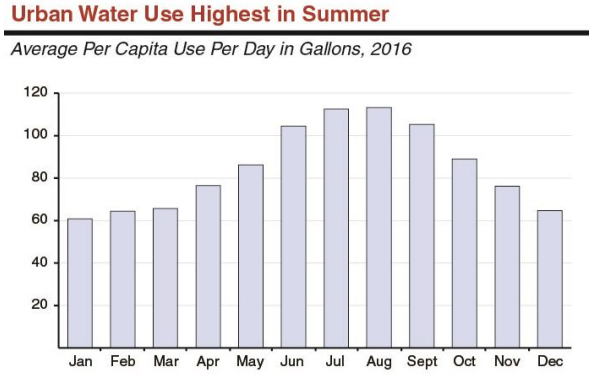

Fig.3. Amount of water use per month in California. [5].

B. *A possible solution*

The previous data show links between each case, which is the high consumption of water in these places of the world. Although there are measures and regulations that control the inappropriate use of water, it is not enough to fight against water scarcity. The development and implementation of new technologies and processes will help to reduce the potable water consumption through the reuse of the resource. An alternative to the current situation is the use of greywater treatment systems since its use represents a saving of around 50% of drinking water [3]. For this reason, the implementation of different filter systems can generate an important saving in drinking water consumption. Furthermore, these systems can be used in any home and anywhere in the world.

III. Types of Filters

This section presents the different types of filters that can be used to carry out the proper treatment of greywater. These consist of a series of physical, chemical and biological processes that remove contaminants from the water. In addition, their advantages and disadvantages will be mentioned.

A. *Filter with Ozone and Ultraviolet treatment*

Most greywater requires proper treatment against bacteria, microorganisms, and other compounds that can be found dissolved in the water. Flotender [6], a company that is responsible for marketing filters, and National Small Flows Clearinghouse [7], an organization that helps small communities and individuals solve their wastewater problems through objective information on wastewater treatment and collection systems, present two filters that meet the requirements for this role. One is based on an ozone treatment and the other on an ultraviolet treatment.

The ozone treatment works by capturing the oxygen found in the air and transforming it into ozone through electricity. Ozone is a powerful oxidizing agent. The ozone treatment has proven beneficial in terms of the amount of oxygen needed for the process by reducing the chemicals and biological agents present in grey water.

The National Small Flows Clearing House (NSFC) [8] and Flotender [9] present advantages and disadvantages of this treatment. It is highlighted that this treatment does not have any type of risk and is not needed to do a treatment. Greywater can be contained longer in a timed irrigation system. Also, once the microorganisms are eliminated, they do not regenerate again. However, the type of material to carry out the ozonation must be of high resistance to corrosion and is an expensive treatment with high energy demand.

The ultraviolet treatment is the other greywater disinfection alternative. Flotender explains that this treatment safely and correctly controls bacteria and reduces the chemicals present.

As in the previous case, the NSFC communicates the different advantages and disadvantages of this type of treatment to filter greywater. This is a physical treatment that does not generate dangers of corrosion and disinfection is also carried out in a short time. The disadvantages of this treatment are the regeneration of the destroyed organisms and, in some cases, the ineffectiveness of the treatment, for example when a low dose of UV rays is used and the turbidity and solids found in the water exceed 30 mg/L.

B. *Physical water treatment filters*

The Aqua2Use system [10] is a filtration system that uses physical methods to separate the components that grey water contains through different layers of synthetic filters. Synthetic filters vary its density and permeability, so it achieves retention of particles from larger to smaller size. According to Matala Water Technology Co., there are four types of layers with different densities, listed below [11, p.1]:

- "Matala FSM190 Black" extra-low density
- "Matala FSM290 Green" medium density
- "Matala FSM365 Blue" high density
- "Matala FSM460 Grey" extra-high density

It is important to make use of the correct materials to obtain better results. In this sense it is stated that "Matala is made of curly fiber Thermo-Polypropylene Compounds (TPPC) or Thermo-polyethylene Compounds (TPEC) that are formed into layers and shapes of different thickness. The formula of the TPPC and the thickness of the fiber used will determine the structure of the filter media, their specific surface, their density and stiffness" [11, p.1].

The Aqua2Use system [10] has as an advantage its ease of installation and operation of its components. Besides this, the recently treated water can be utilized or stored in a water tank to later recharge the toilet or the laundry machine, wash the car and irrigate a garden. Although storage water tanks of this system take up a lot of space, it is important to have these tanks to maximize greywater use so it is the principal disadvantage.

C. *Sand filter*

This type of filter is normally used to filter water of domestic pools or club pools. As well as this, this method is also utilized for potable water treatment but on a large scale. Considering the aforementioned, this system can also be used for greywater treatment as it has great filtration capacity.

The sand filter is a simple technology, easy to implement and inexpensive too [12, p.5]. Therefore, this simple solution is considered an advantage. The periodicity of maintenance that this filter presents is a disadvantage because greywater carries a lot of particles that can impair its optimal performance due to the waste generated.

IV. Comparative analysis

The present section addresses the implementation of the greywater treatment systems previously mentioned. There are some problematic issues that appear in existing houses so changes must be made, and it implies plumbing work. On the other hand, the advantages that a new house represents over an existing house will be explored.

A. *Existing houses*

In the case of existing houses, they have a conventional sewage system that join greywater and blackwater due to the fact that this waste goes to the same place.

The main problem is in the bathroom as it means making repairs on the floor and parts of the structure to make changes in the sewage system and, in this way, to carry the fluids to the place where the greywater treatment system is installed. Fig.4 shows how is a conventional bathroom connection.

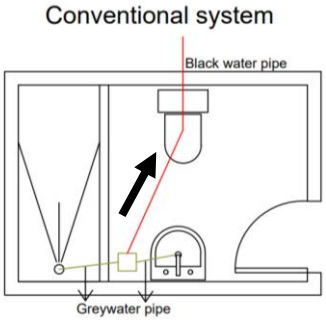

Fig. 4. Scheme of conventional bathroom connection.

One way to solve this problem is making a fluid separation through a connection to another liquid collection camera to carry the greywater to the installed treatment system. Fig.5 shows the possible solution scheme.

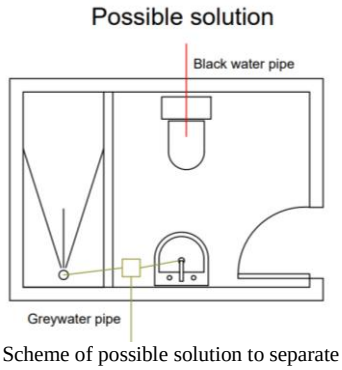

Fig.5. Scheme of possible solution to separate fluids.

If other sources of greywater such as laundry machine or the kitchen sink want to be implemented, the needed changes generally are smaller than in the bathroom. However, these factors depend on the house design.

B. *New Houses*

Making an installation of a greywater treatment system in a new house is easier than in existing houses since the treatment system is included in the design from the beginning. In this way, modifications to the structure and services are not necessary. In these cases, it is essential to carry out a complete study of the system that will be installed to avoid problems and achieve more efficiency.

V. Conclusion

This paper has presented an efficient way to reutilize large amounts of water in houses using different greywater treatment systems. In this way, it is possible to reduce the total freshwater consumed in a house.

Water scarcity is a problem that has increased over the years, and it has expanded around the world. Therefore, generating new and more sustainable consumption habits to take care of scarce resources is important.

There exist several ways to construct and install a greywater treatment system. The systems that were presented in this paper give a general vision about the way that these systems work and the variety of products that are available and can be used. The kind of treatment system election depends on several factors such as the type of

house, budget, availability of the product according to the place of installation, amount of water to recycle, fate of recycled water, among others.

A better use of a scarce resource such as water is possible through its reuse with a filter treatment system. Each kind of treatment system offers different advantages and possibilities and the election of it depends on each case. The truth is that the implementation of these systems is a great possibility for reducing freshwater consumption.

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